RTC – an interface between TASCA and chemistry

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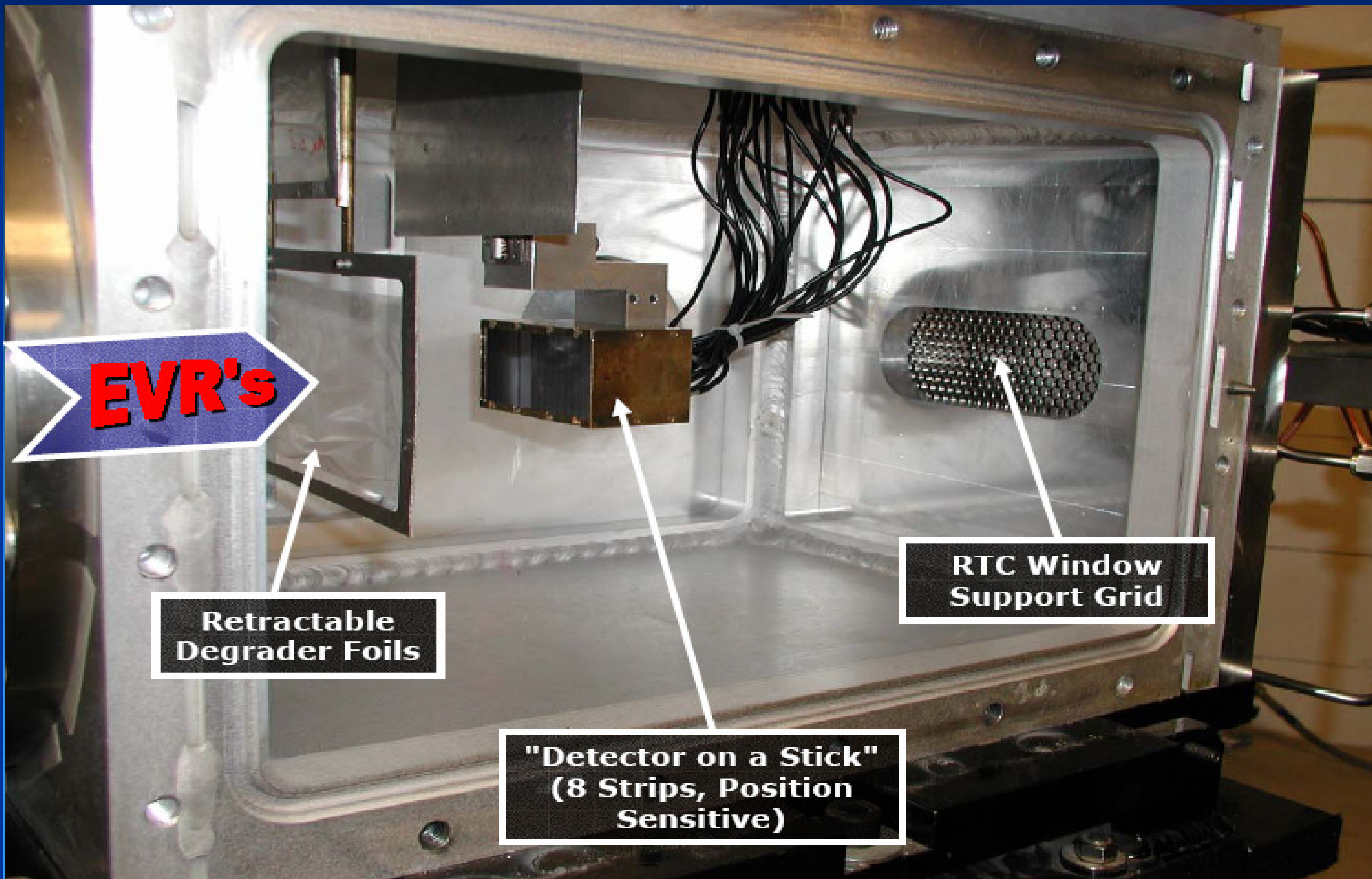
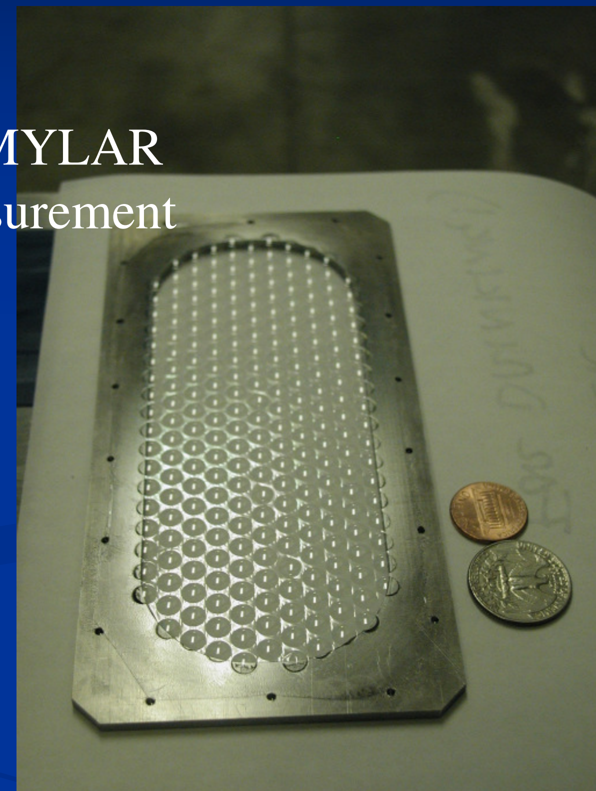
View on RTC from BGS side



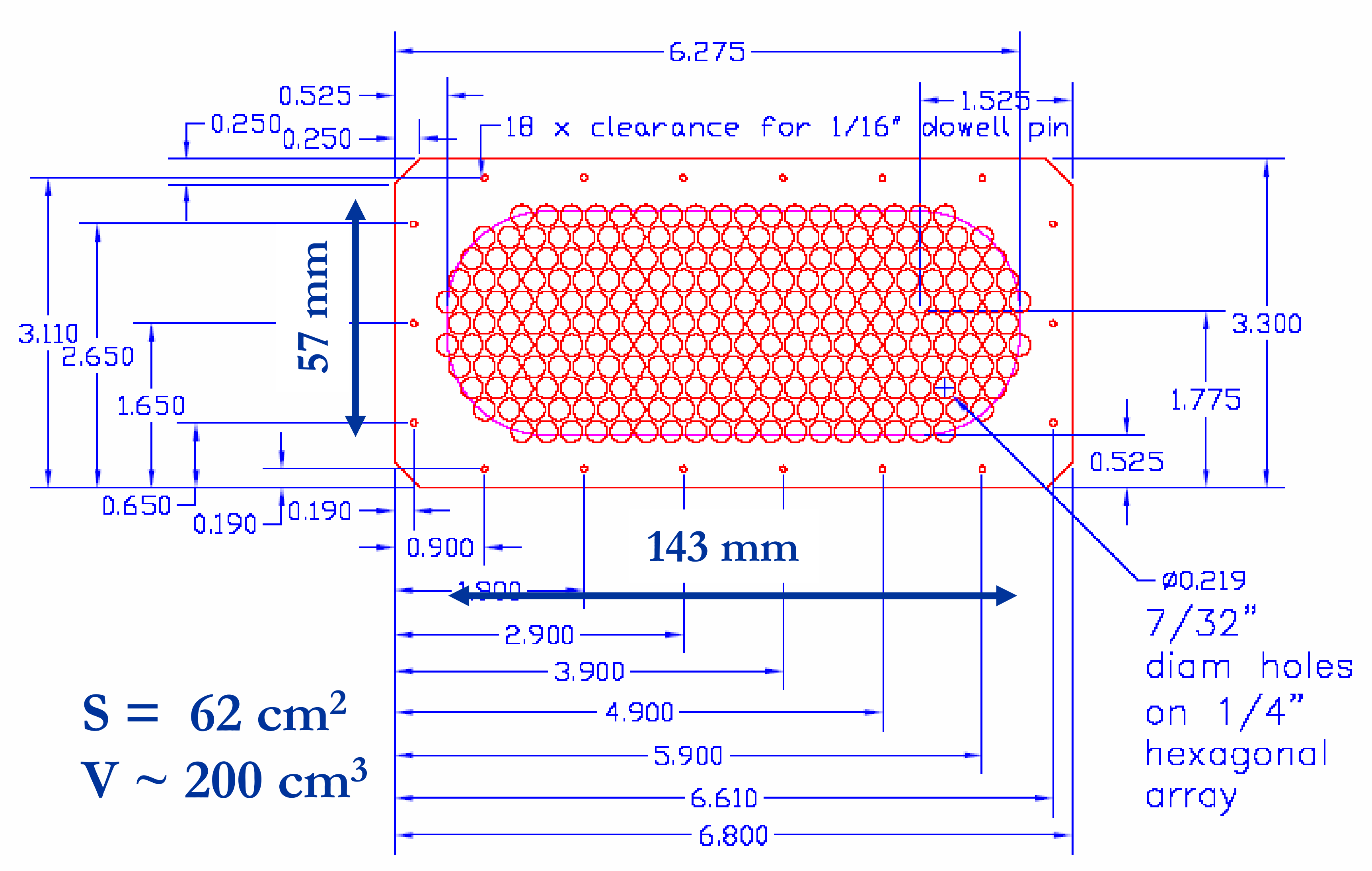
RTC & BGS and RIKEN

Smaller (fixed) volume
Honeycomb grid allows thinner MYLAR
Catcher foil holder for yield measurement



Thickness of Mylar foil : 2.5 μm
Honeycomb mesh : 0.5 mm thick SS
Transparency of mesh : 93 %

Window support (BGS)



S = 62 cm²

V ~ 200 cm³

Hole diameter ~ 5.5 mm →

High transparency, but does not allow to work with Mylar < 2 μm

Development of a gas-jet chamber coupled to GARIS

(i) Vacuum window

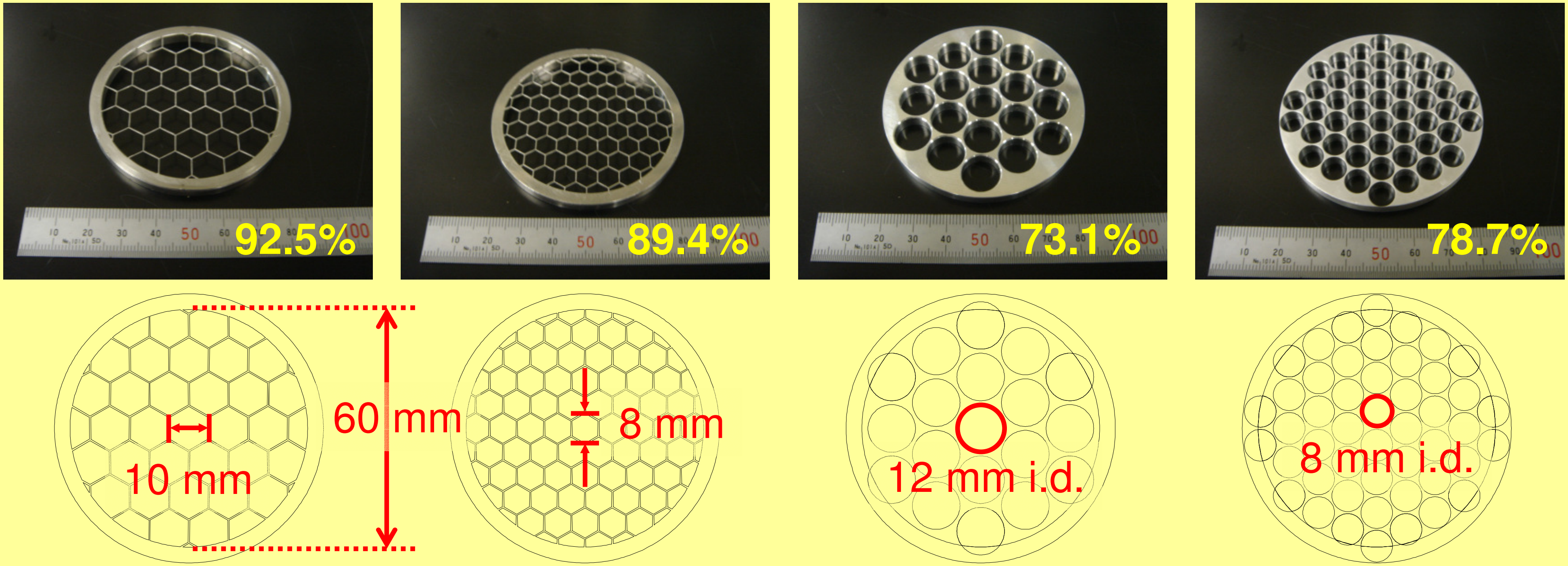
Focal plane of GARIS: PSD (60 x 60 mm^2)

⇒ Mylar vacuum window of Φ60 mm

Mylar foil: 1.1, 2.4, 2.6, 3.1, and 5.6 μm

Mylar foils down to 2.4 μm are available at 100 kPa using all types of support grids!

Honeycomb | Circle



Reaction	Nuclide	E_{Recoil}	R_{Mylar}
$^{244}Pu(^{48}Ca,3n)^{289}114$	$^{289}114$ 3 s	39.9 MeV	✓
$^{238}U(^{48}Ca,3n)^{283}112$	$^{283}112$ 4 s	39.3 MeV	✓
$^{244}Pu(^{30}Si,5n)^{269}Hs$	^{269}Hs 14 s	18.1 MeV	2.9 μm
$^{244}Pu(^{27}Al,4n)^{267}Bh$	^{267}Bh 15 s	14.4 MeV	2.6 μm
$^{244}Pu(^{26}Mg,5n)^{265}Sg$	^{265}Sg 7 s	13.5 MeV	2.4 μm
$^{244}Pu(^{23}Na,5n)^{262}Db$	^{262}Db 33 s	10.8 MeV	1.9 μm
$^{244}Pu(^{22}Ne,5n)^{261m}Rf$	^{261m}Rf 78 s	9.5 MeV	1.7 μm

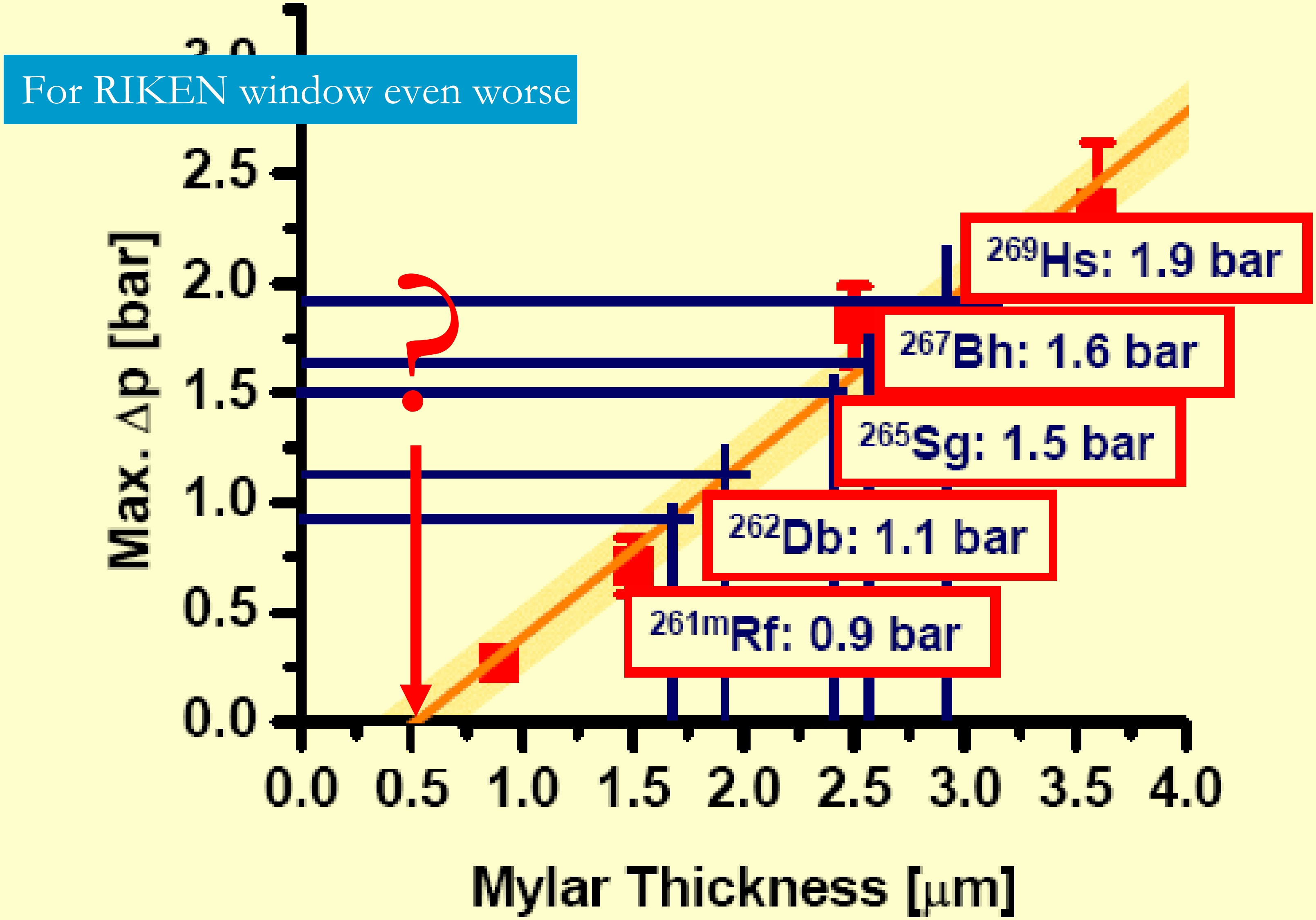
RTC window materials

For hot fusion reactions RTC window made from

- ☺ Mylar ≤ 1.5 μm
- ☹ Be ≤ 1 μm
- ☹ Ni ≤ 0.25 μm

Metal foils	to high stopping power very thin foils are not vacuum tight
Ceramic	more difficult to handle small size
Polymeric foils	vacuum tight (with thin Al layer) but lower mechanical and thermal stability

Maximum allowable pressure on Mylar

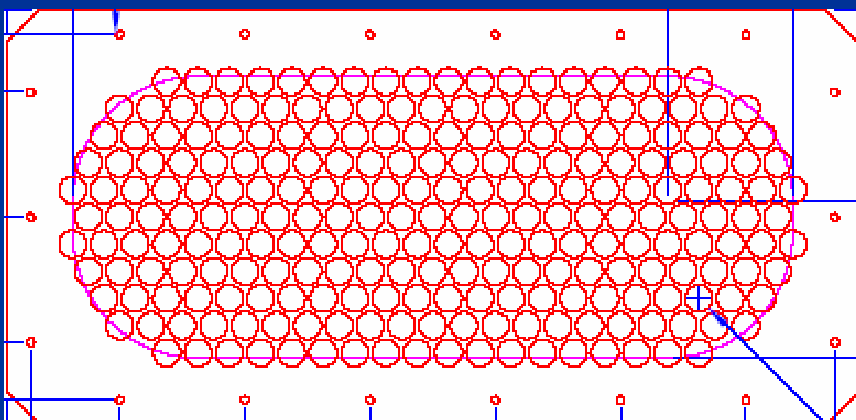


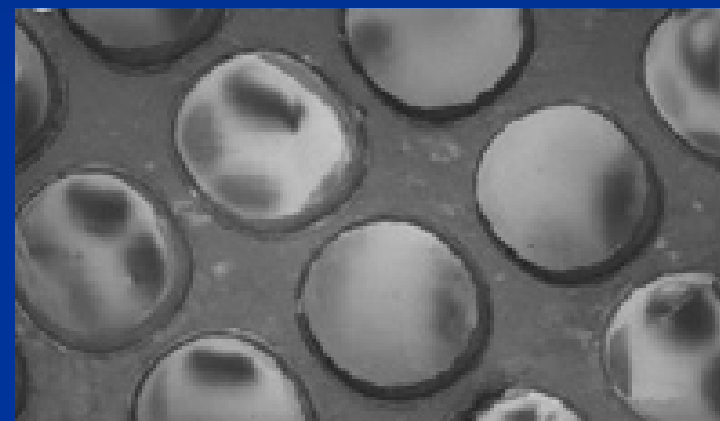
These numbers are for our 80%-transparency honeycomb support; the accuracy is limited, but it should give some feeling for what will be possible. Suggestions for better materials and and support designs are highly welcome!

How to use thin Mylar?

5.5 mm holes are too large

Micro holes





Electro forming
Plasma etching

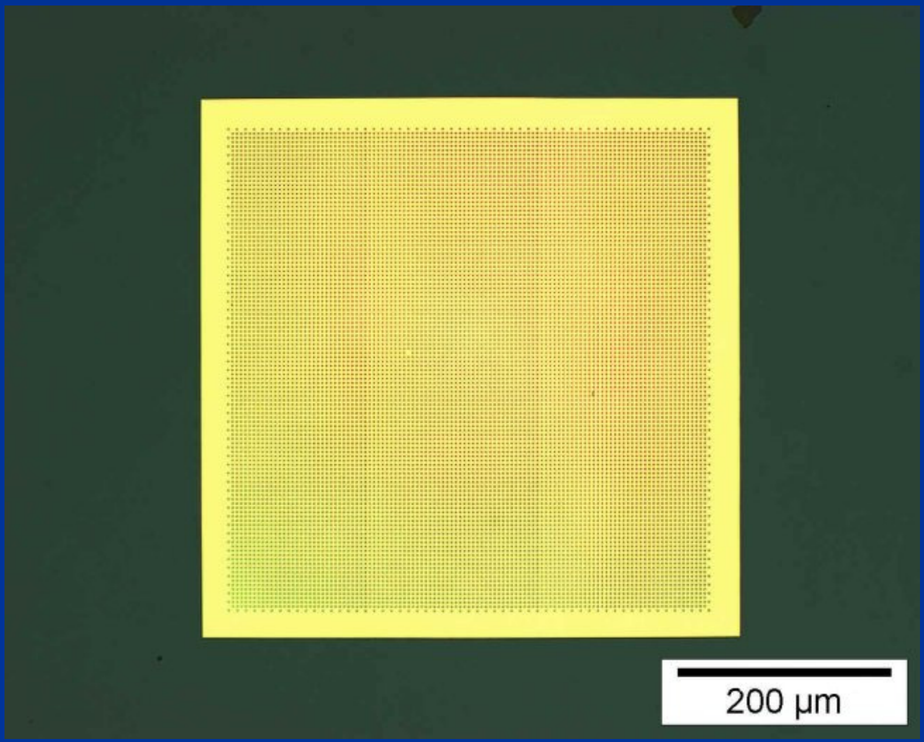
Electro etching
Laser cutting

Example (Lebow)

300 mesh		hole	bar	transmission
0.63mm	40 lpi*	0.60mm	0.03mm	94%

25µ Stainless, etched
needs add. support

Alternatives to Mylar



- 👍 Extremely thin ~50nm
- 👍 Vacuum tight
- 👍 Stable

- 👎 Small size
- 👎 Low transparency

Si_3N_4 membranes

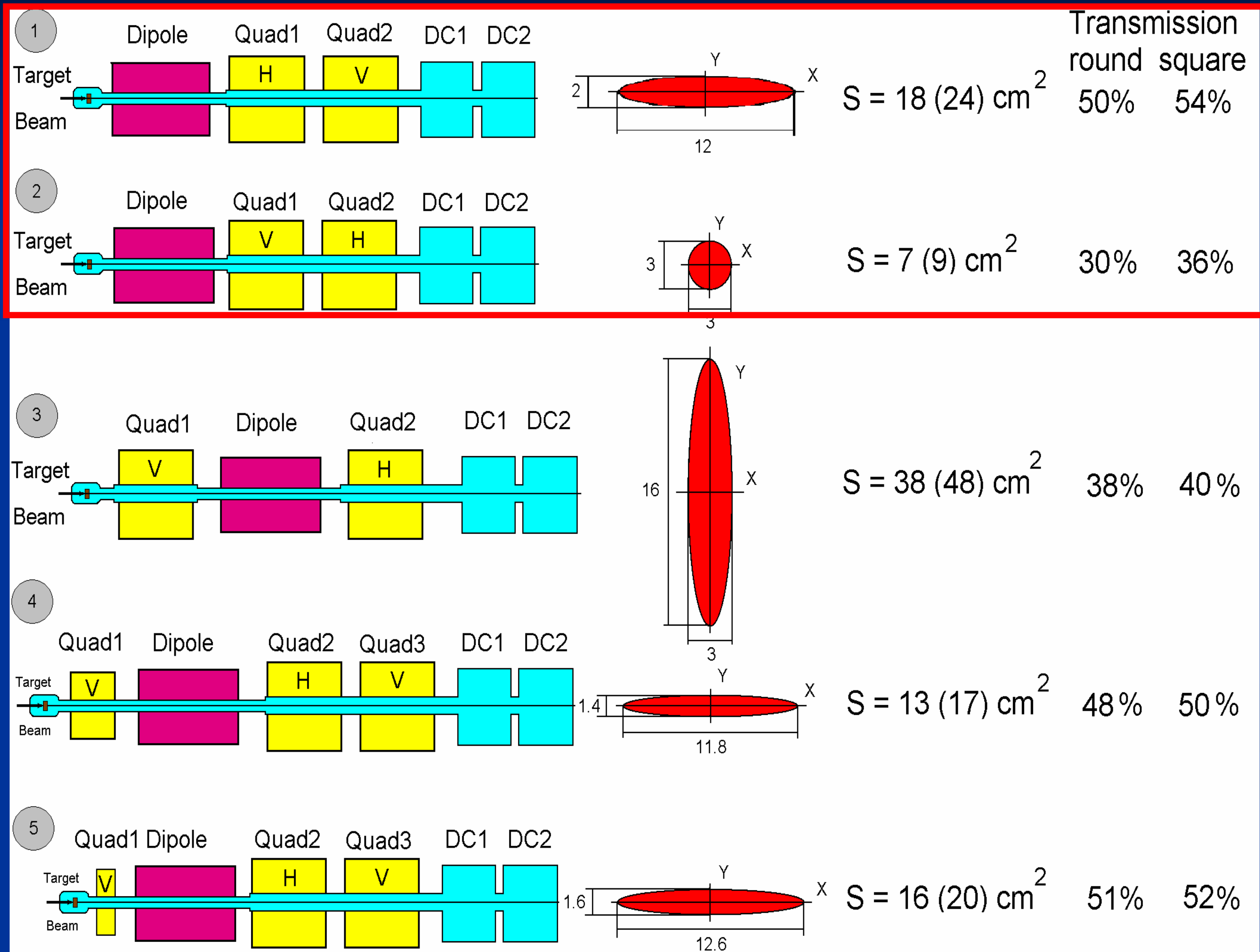
RTC window - solution?

- MOXTEK proportional counter windows
  - Active area 5 mm x 25 mm; 20 mm x 30 mm or custom
  - Support Silicon grid 76% open area
  - Differential pressure limits 1.5 atm (frontside)

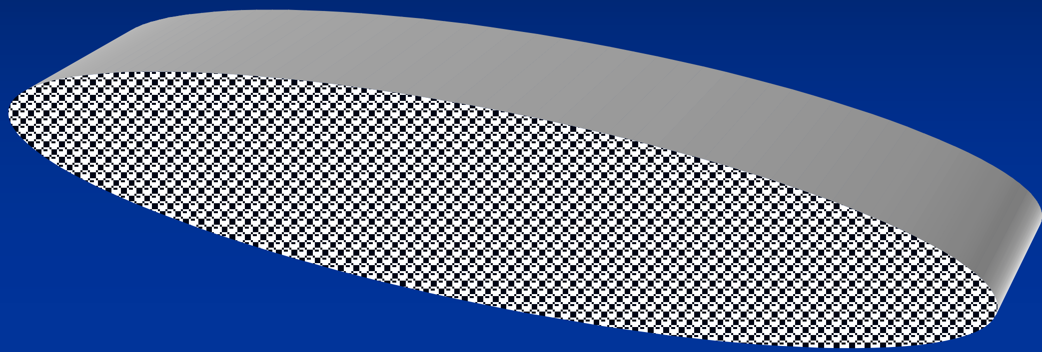
    0.3 atm (backside)
  - Vacuum tightness < 1 x 10^{-10} mbar L/sec He
  - Pressure cycling performance >100000 cycles (1.2 atm)
  - Temperature performance 85^{o}C at diff. pressure 1 atm
  - Chemical compatibility resistant to solvents, acids, bases
  - Polymeric foil thickness (6 cm^2) 0.45 μm !!!

As thin as possible vacuum tight polymeric foil on a support with small holes(i) and high transparency(ii)

Summary data at the exit focus

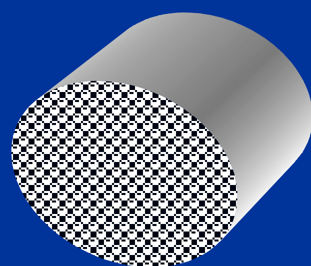


Transmission vs. chemical yield



Transmission 54%
$S = 24\ cm^2$ (2x12 cm)
$V \sim 75\ cm^3$
$t_r \sim 3$ s

Transmission 36%
$S = 9\ cm^2$ (3x3 cm)
$V \sim 27\ cm^3$
$t_r \sim 1$ s



More stable window against gas pressure

For short-lived products small RC is more efficient

Transport from RTC to chemistry

- <u>Gas flow</u>

  Gas phase chemistry with volatile species

  Same yield as in gas phase chemistry without pre-separator

- <u>Aerosol jet</u>

  Gas or liquid phase chemistry

  High pressure difference between RTC and chemical apparatus → high pressure in RTC

- <u>No gas transport</u>

  "Liquid transport"

  Vacuum chromatography coupled to RTC

How to increase transport yield?

- Decrease volume of the RTC

  - optimize EVR spot size

  - increase gas stopping power (He/Ar mixture)

  - degrader foil

- Short transport line

  – bring you chemical apparatus close to the separator

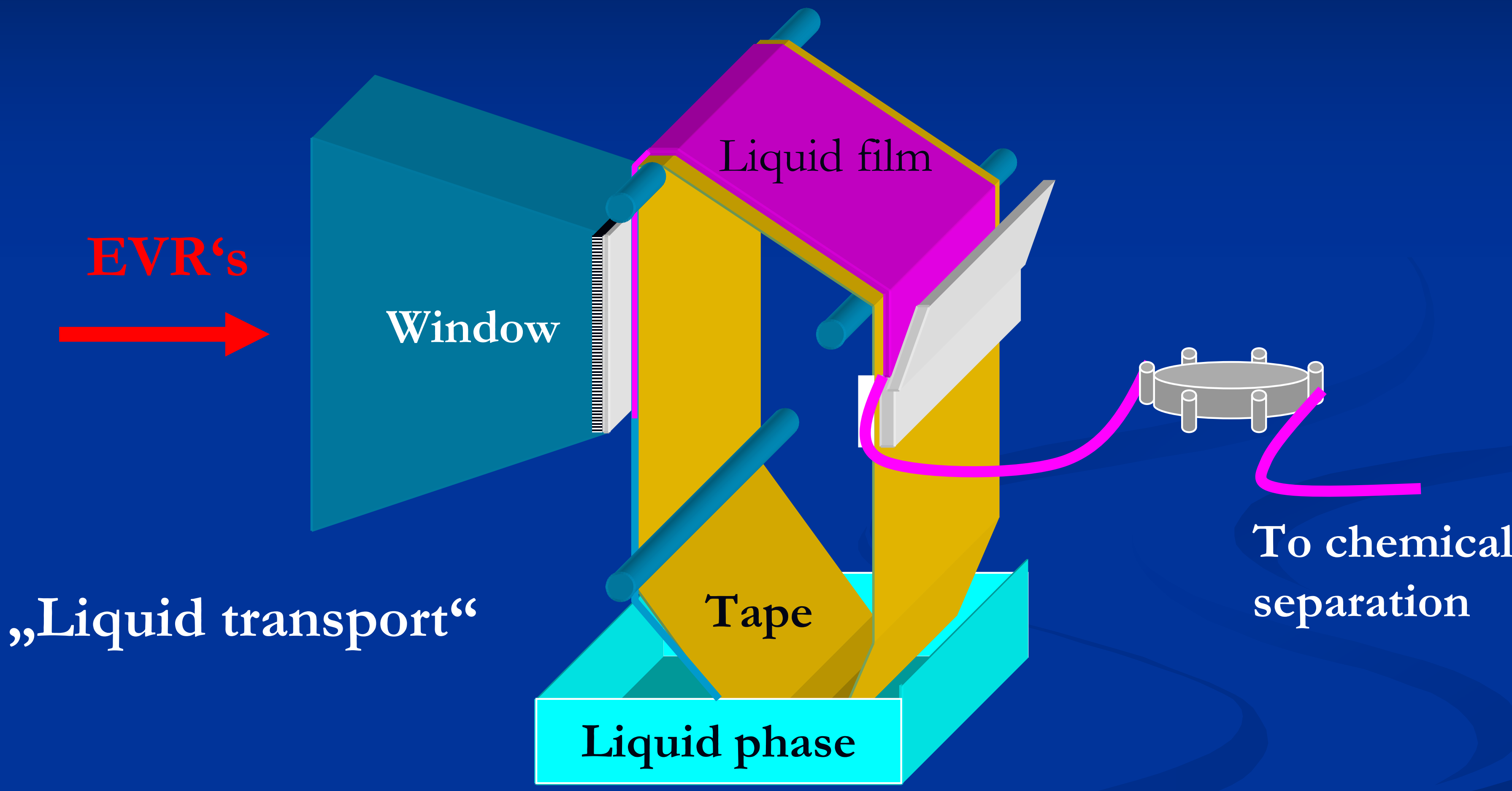
- Multi-parameter optimization

  - nuclear reaction (transmission, EVR spot size, EVR energy, half-life, window thickness); chemical yield (transport and reaction time), detection after chemistry

- Improvments in chemistry

  - work in loop, more effective device to bring products into solution, liquid-solid extraction instead liquid-liquid one, detection by Si detectors

Transport yield – solution?



New possibilities to bring activity into solution have to be find!